OCR
Oxford Cambridge and RSA

Monday 15 May 2023 – Morning

AS Level Geology

H014/01 Geology

Time allowed: 2 hours 30 minutes

You must have:
- a ruler (cm/mm)
- a protractor

You can use:
- a scientific or graphical calculator
- an HB pencil

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H014014

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **120**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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Section A

You should spend a **maximum** of **30 minutes** on this section.

Write your answer to each question in the box provided.

1 A common, rock-forming mineral can be scratched by a steel nail but not by a copper coin. It has two obvious cleavages at right-angles to each other.

Which rock-forming mineral has these properties?

A Augite

B Mica

C Olivine

D Quartz

Your answer ☐ **[1]**

2 The susceptibility of a mineral to weathering depends on both its mechanical strength and its chemical stability.

Which mineral structure is most resistant to weathering?

A Chains

B Sheets

C Frameworks

D Silica tetrahedra

Your answer ☐ **[1]**

3 Which property of igneous rocks seen in the field is **most** useful in distinguishing a lava flow from a sill?

A Mineralogy

B Number of baked margins

C Xenoliths from the bed below

D Crystal size

Your answer ☐ **[1]**

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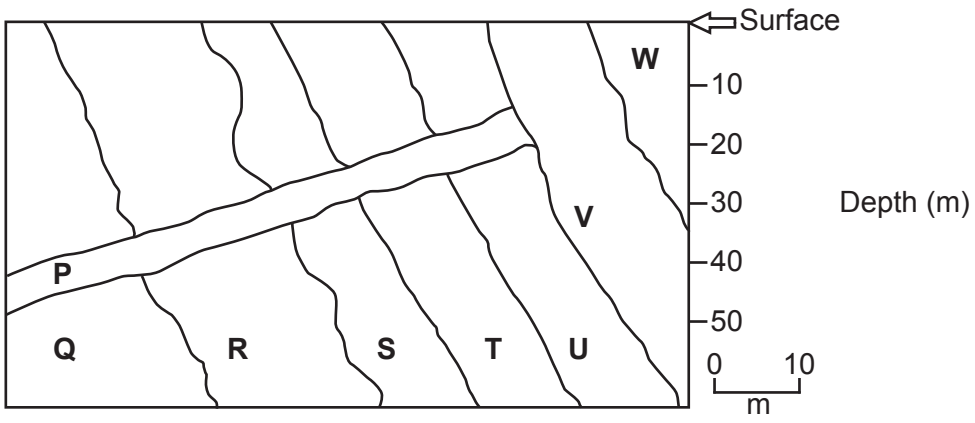
This is a sketch of a cliff section containing two **intrusive** igneous rock units (**P** and **T**) in a sedimentary succession.

Use this sketch to answer questions 4 and 5.



4 Which word describes rock **T**?

A Batholith

B Dyke

C Lava flow

D Sill

Your answer ☐ **[1]**

5 Which sequence describes the order the rock units in the sketch of the cliff section were formed?

A P Q R S T U V W

B Q R S U T P V W

C Q R S T U V W P

D W V P U T S R Q

Your answer ☐ **[1]**

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6 In igneous rocks, the size of the crystals depends mainly on:

- the rate of magma cooling, linked to how close the magma is to the margins of the igneous body
- the volume of magma that crystallised.

Which igneous body is **most** likely to contain medium grained crystals at its centre?

A Batholith

B Dyke

C Lava flow

D Pluton

Your answer ☐ **[1]**

7 A diorite is analysed for its mineral content and mean crystal size.

Which description shows the results from the analysis of the diorite?

A 30% quartz, 45% orthoclase, 15% plagioclase, medium crystals

B 50% pyroxene, 50% olivine, coarse crystals

C 60% plagioclase, 40% pyroxene, fine crystals

D 70% plagioclase, pyroxene + hornblende + biotite 30%, coarse crystals

Your answer ☐ **[1]**

8 What allows the **bulk** composition of the Earth to be inferred?

A Samples brought back from the Moon

B The composition of chondrites

C The composition of the crust

D The mean density of the Earth

Your answer ☐ **[1]**

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9 Which statement explains why the Moon has so many more craters than the Earth?

A The Moon does not rotate on its axis.

B The Moon has no plate tectonism.

C The Moon is older than the Earth.

D The Moon's orbit intercepts more meteorites.

Your answer ☐ **[1]**

10 The ratio of P-wave to S-wave velocity is 1.7. A P-wave arrives at a point after travelling for 40 s.

How long is the **delay** until the S-wave arrives at the same point as the P-wave?

A 24 s

B 28 s

C 68 s

D 74 s

Your answer ☐ **[1]**

11 What does **not** provide indirect evidence for the geodynamo origin of the Earth's magnetic field?

A Changes in the position of magnetic poles

B Magnetic reversals

C Magnetism can be preserved in mafic rocks

D The magnetic field appears to originate from the Earth's centre

Your answer ☐ **[1]**

12 Which group would make the best zone fossil over the longest time period?

A Cephalopods

B Bivalves

C Brachiopods

D Trilobites

Your answer ☐ **[1]**

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13 A rock sample was found to have no crystals or grains visible to the naked eye and a Moh hardness of 3. It contains the tests of planktonic foraminifera.

Which environment is the rock most likely to have been formed in?

A Deep water carbonate seas

B Deltas

C Playa lakes

D Reefs

Your answer ☐ **[1]**

14 Nappes result from deformation in which tectonic settings?

A Continental rifts

B Fold mountains

C Ocean ridges

D Transform faults

Your answer ☐ **[1]**

15 There is a substantial negative free-air gravity anomaly over Northern Scandinavia which results from the loading of the crust in the last ice age.

What does this anomaly suggest?

A The area has reached isostatic equilibrium.

B The mountains have 'roots' which compensate for their mass.

C The 'roots' are shallower than needed for isostatic compensation.

D The 'roots' are deeper than needed for isostatic compensation.

Your answer ☐ **[1]**

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16 What is **not** a property of the lithosphere?

A Composed of crust and upper mantle

B Divided into tectonic plates

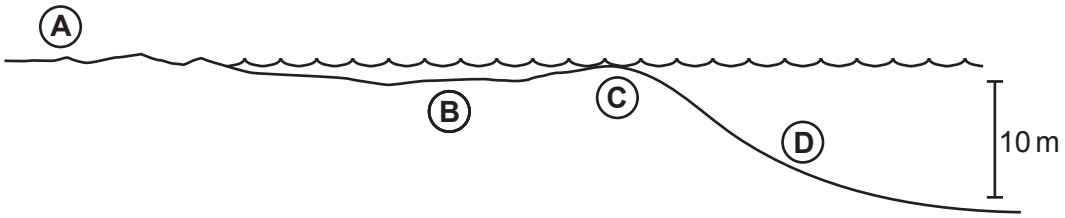
C Rheid, plastic layer

D Varies in thickness

Your answer ☐ **[1]**

17 The diagram shows a section through a carbonate dominated shoreline.

What is the most likely site for the formation of micritic limestone?



Your answer ☐ **[1]**

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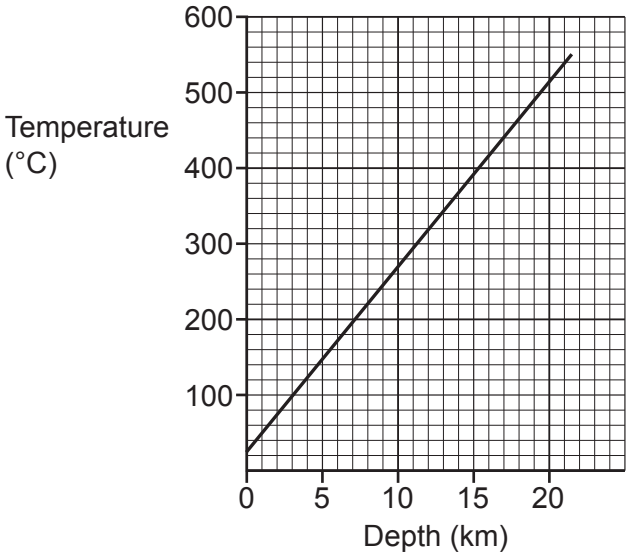
18 The graph shows the increase of temperature with depth in the continental crust.

Calculate the geothermal gradient.



A $0.25\,°C\,m^{-1}$

B $0.27\,°C\,m^{-1}$

C $25\,°C\,km^{-1}$

D $27\,°C\,km^{-1}$

Your answer ☐ **[1]**

19 The rate of increase of temperature with depth is not continuous and must change at some depth.

Which statement describes the evidence for this observation?

A There is only partial melting in the mantle.

B The outer core is a liquid.

C The melting point of the mantle increases with depth.

D There is high heat flow at ocean ridges and hotspots.

Your answer ☐ **[1]**

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20 Which statement about mid-ocean ridges is **not** correct?

A Heat flow is higher than average across a mid-ocean ridge.

B Mid-ocean ridges are always mid-ocean due to the spreading process.

C Mid-ocean ridges are dominated by mafic volcanism.

D Ridge push is involved in sea floor spreading at the mid-ocean ridge.

Your answer [ ] **[1]**

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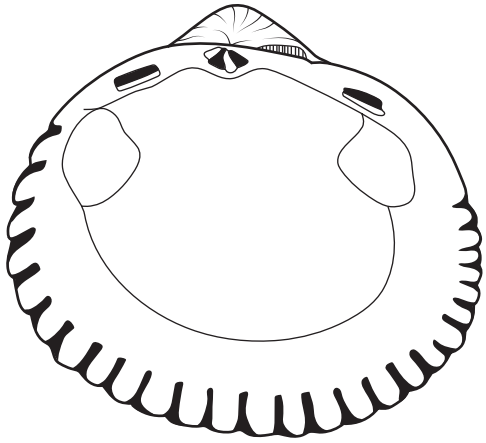
Section B

21 (a) **Fig. 21.1** shows part of a fossilised bivalve, preserved in shallow-sea sediments laid down 20 Ma ago. The shell was originally made up of aragonite (a form of calcium carbonate).

Fig. 21.1



(i) Describe how the bivalve would have been preserved.

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..... **[2]**

(ii) **On Fig. 21.1**, label **one** feature which shows that the bivalve lived in a shallow sea palaeoenvironment. **[1]**

(iii) The bivalve was preserved in shallow-sea sediments.

Describe how this palaeoenvironment preserved the bivalve.

.....

..... **[1]**

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(iv) Given the morphology of the fossil shown in **Fig. 21.1**, describe the preservation potential of the fossil **and** explain the reason for your choice.

Preservation potential .....

Explanation .....

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.....

[2]

(v) Other, external, factors can influence the preservation of the fossil.

Describe **three** external factors **and** explain how each affects the chances of preservation.

1 .....

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2 .....

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[3]

(vi) Describe how the preservation potential will have influenced the fossil record.

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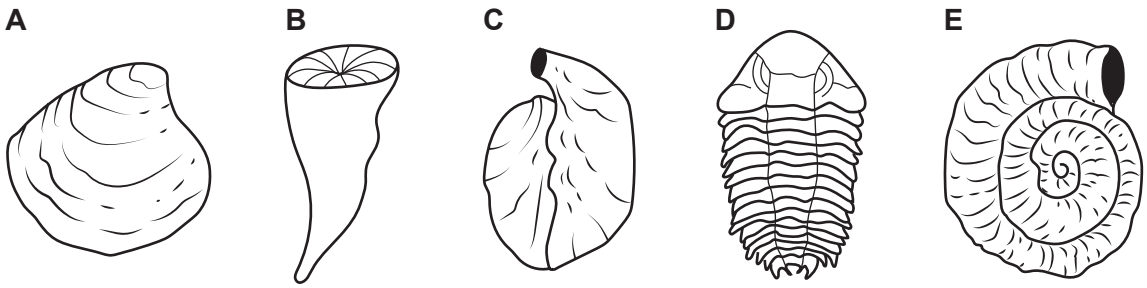
(b) **Fig. 21.2** shows external views of five fossils, **A** to **E**, that represent fossil invertebrate groups.

Fig. 21.2



(i) Complete the table by stating the broad fossil group represented by fossil diagrams **A** to **E**.

	Classification (group)
A	
B	
C	
D	
E	

[2]

(ii) Most of the groups in **Fig. 21.2** were found in the Phanerozoic eon but one group is only found in one era.

Give the letter, **A** to **E**, for the group found in one era and name the era.

Group .....

Era .....

[2]

(iii) Explain the basis of the division of the Phanerozoic eon into eras.

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..... **[2]**

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22 The photograph shows faulting in the Carboniferous loggerheads limestone formation on Anglesey, looking due West.

25 cm

(a) Draw a labelled sketch in the box next to the photograph to show the main features of the geological structures. **[3]**

(b) Draw on **and** measure the throw of the fault.

Give the unit for your answer.

Throw = ... Unit = ... **[2]**

(c) What is the angle **and** apparent dip of the fault plane?

..... **[2]**

(d) Explain why only the **apparent** dip has been measured and what information it provides about the **true** dip.

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..... **[2]**

(e) What sort of tectonic environment has caused the fault in the photograph?

..... **[1]**

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23 (a) (i) A student plans to take measurements of mean clast size in a conglomerate outcrop formed by a river. The purpose is to test how water velocity changed across the river.

Describe how the fieldwork should be done to ensure accurate results.

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..... **[3]**

(ii) Describe how measuring clasts in outcrop, and measuring clasts in a modern sediment laid down in similar conditions, affect the results.

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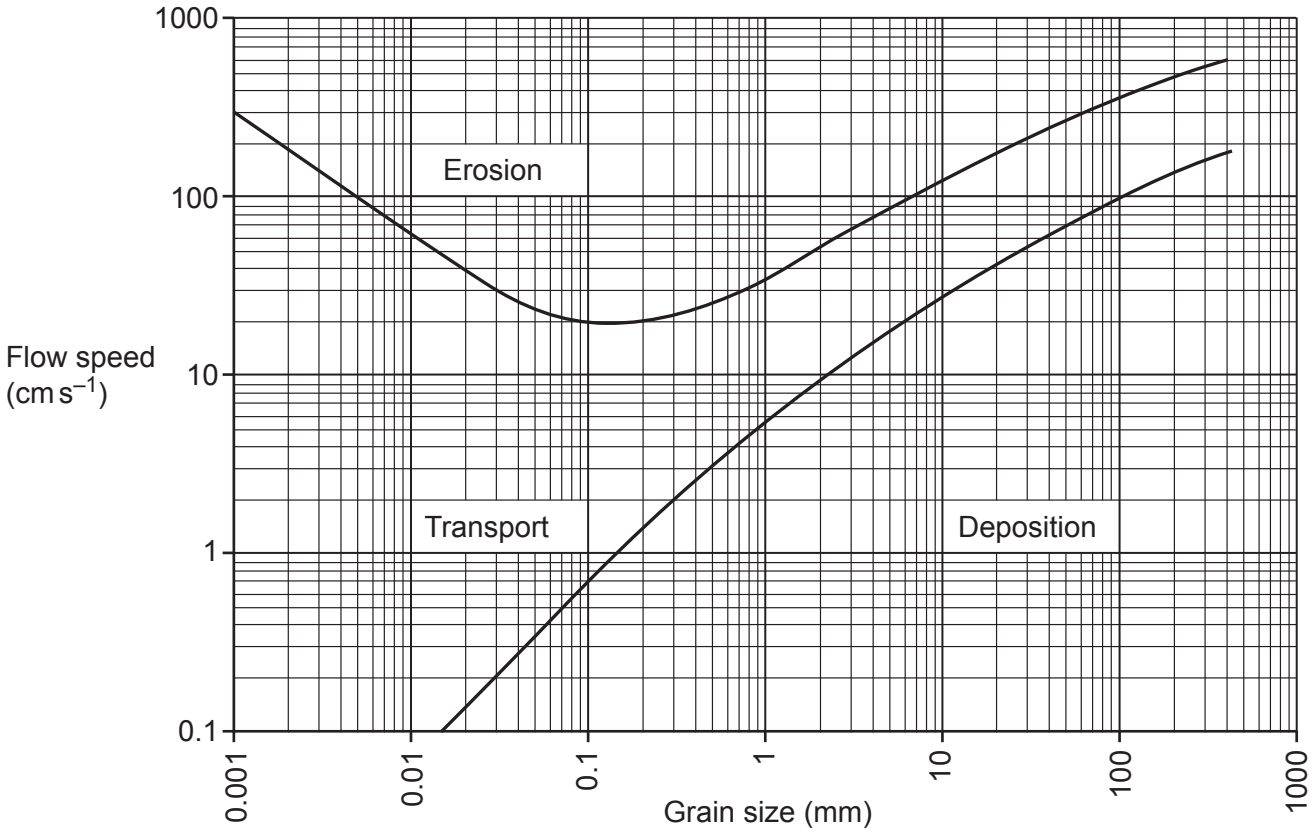
(b) Information on the velocity of palaeocurrents and grain size linked to erosion, transport and deposition is shown in the Hjulstrôm curves in the graph.



The table shows measurements made of the three axes of five clasts, **A** to **E**, taken from a river deposit.

Clast	Long axis (mm)	Intermediate axis (mm)	Short axis (mm)
A	64	39	8
B	138	85	17
C	240	148	29
D	152	94	19
E	96	59	12

(i) Calculate the mean clast diameter of the sample.

Mean clast diameter of the sample = ... mm **[1]**

(ii) Using the graph, state the flow velocity of the river.

Flow velocity of the river = ... cm s^{-1} **[2]**

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(iii) River flow rates can change rapidly and often a surge of water is followed by a declining flow rate.

Estimate the maximum flow rate implied by the clast measurements.

Give units in your answer.

Estimated maximum flow rate = ... Units = ... **[2]**

(c) (i) Describe the shape of the clasts in the sample.

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..... **[2]**

(ii) Suggest the **type** of rock which, on erosion, could have produced clasts of this shape.

..... **[1]**

(iii) When clasts of this shape are deposited by a river they often produce a sedimentary structure that provides vital information on the environment of deposition.

Identify the sedimentary structure.

..... **[1]**

(iv) Describe how the sedimentary structure named in **23(c)(iii)** can be interpreted.

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..... **[1]**

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24 (a)* Seismic tomography exploits changes in the velocity of seismic waves.

Describe how the arrival times of seismic waves from several earthquakes could be used to identify the presence in the mantle of a subducted slab and a mantle plume.

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Additional answer space if required.

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(b) Seismology was a key factor in developing the plate tectonic paradigm.

(i) Explain how evidence from global seismicity can allow geologists to define lithospheric plates.

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(ii) Explain what causes the seismicity of the Benioff zone and how it helped the understanding of plate tectonics.

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..... **[4]**

(c) **(i)** State which tectonic setting shows the highest heat flow measurements.

..... **[1]**

(ii) Explain how heat flow measurements contribute to our present understanding of the transfer of heat within the Earth.

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..... **[1]**

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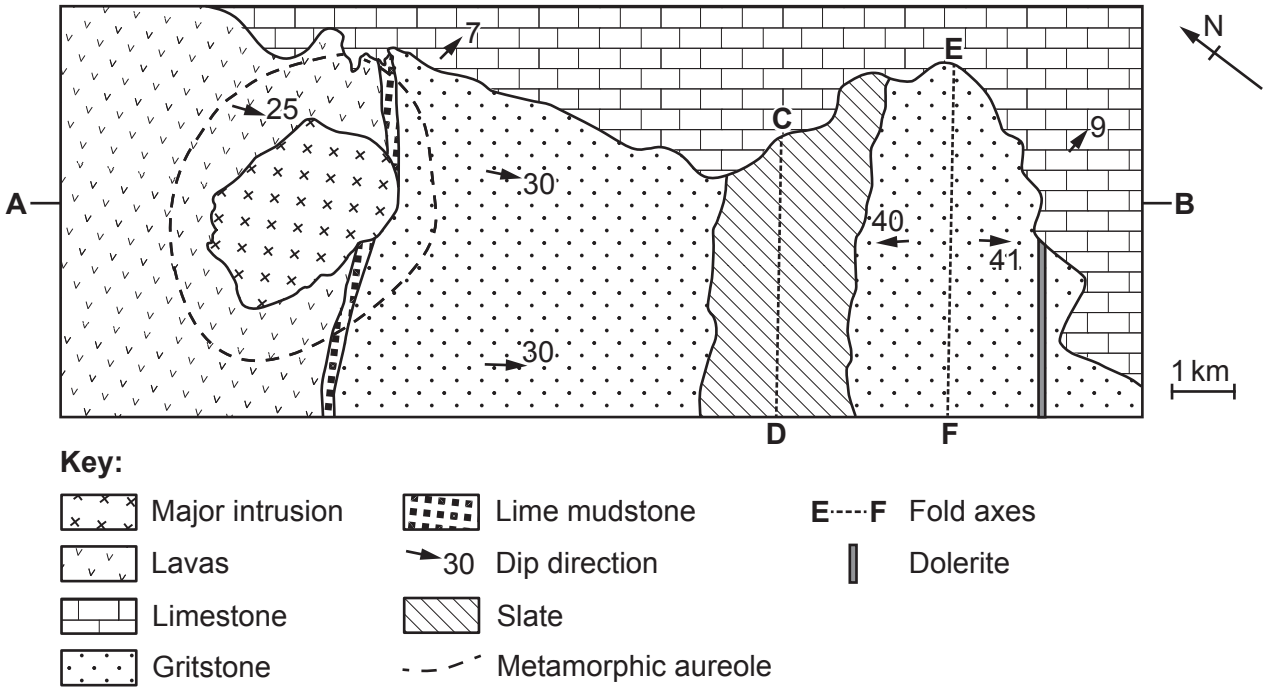
25 **Fig. 25.1** shows an outcrop map based on part of the Lake District.

Fig. 25.1



(a) **(i)** Construct a cross-section along the traverse **A–B**, showing **all** the rock types and their structural relationships onto the scaled section below. Use the same symbols as the key.

[4]

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(ii) Using your cross-section **(a)(i) and Fig. 25.1**, put the geological events in the correct order.

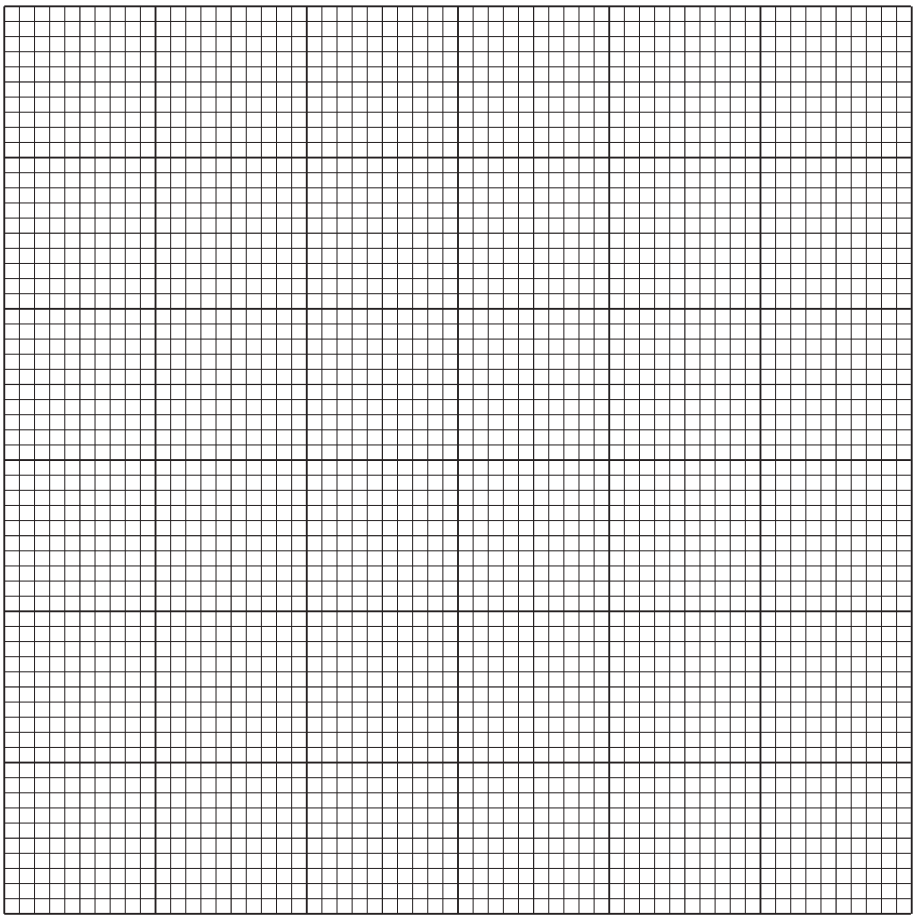
Complete the table by adding numbers from **1** (oldest) to **7** (most recent).

	Order
Erosion and change of sea-level	
Intrusion and metamorphism	
Deposition of lime mudstones	
Eruption of lavas	
Folding on NE-SW axes	
Deposition of gritstones	
Deposition of limestone	

[4]

(b) (i) U^{235} decays to Pb^{207} with a half-life of 704 Ma.

Draw the decay curve for 4 half-lives.



[4]

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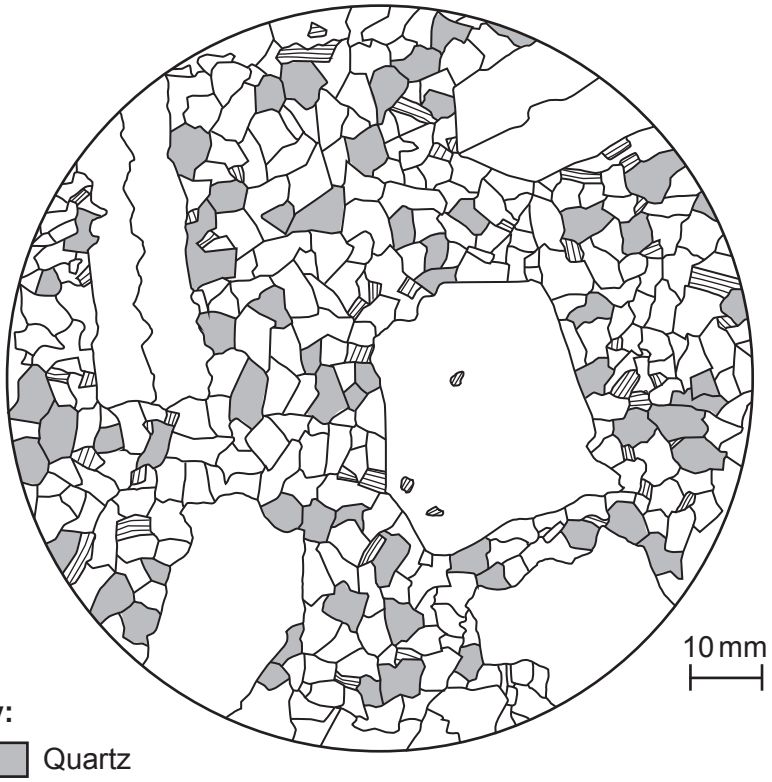
(ii) The major intrusion contains the mineral uraninite with a ratio of U^{235} to Pb^{207} of 66 : 34.

Use your graph to find the age of the major intrusion.

Age = ... Ma **[1]**

(c) (i) **Fig. 25.2** shows a thin-section diagram of the rock that makes up the major intrusion. The large crystals are K-feldspars.

Fig. 25.2



Classify the igneous rock in **Fig. 25.2 and** state the reasons for your choice.

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..... **[2]**

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(ii) Describe the texture **and** explain what this implies about the cooling history and environment in which this rock crystallised.

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..... **[2]**

(iii) There is an anomaly on the map shown in **Fig. 25.1**. The outcrop of the igneous intrusion is approximately 3 km in diameter yet the metamorphic aureole extends for more than a kilometre in places. By contrast, the massive intrusions in Cornwall have a metamorphic aureole that extends some 500 m into the country rocks.

Explain the anomalous width of the metamorphic aureole in **Fig. 25.1**.

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..... **[2]**

(d) Describe the fold on **Fig. 25.1** with the axis labelled **E–F**.

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(e) **(i)** The area shown in **Fig. 25.1** contains slates.

Describe how slates are formed.

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(ii)* Describe how you would use a compass-clinometer to accurately measure the orientation of bedding, cleavage and other geological features in the Lake District rocks.

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Additional answer space if required.

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(iii) Use your cross-section and information from the map to decide upon the most likely strike and dip of the cleavage measured in those slates.

Strike = ... **[1]**

Dip = ... **[1]**

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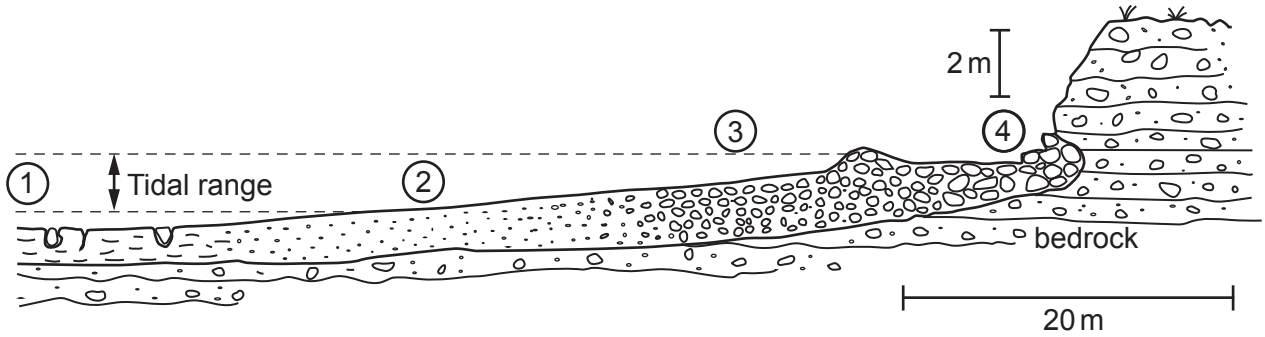
26 As sea levels rise, many coastlines are being eroded. These transgressive shorelines produce a unique sedimentary sequence.

(a) The diagram shows an idealised sequence through a transgressive shoreline.



Key:
1. Bioturbated muds
2. Well-sorted, coarse sands, some ripples
3. Rounded pebbles
4. Pebbles, cobbles and boulders

(i) Explain how the variations in depositional environment account for the four different sediment types shown in the diagram.

There is a plentiful supply of siliciclastic sediment.

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..... **[4]**

(ii) Explain why articulated fossils are only found in position **1** of the diagram.

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..... **[1]**

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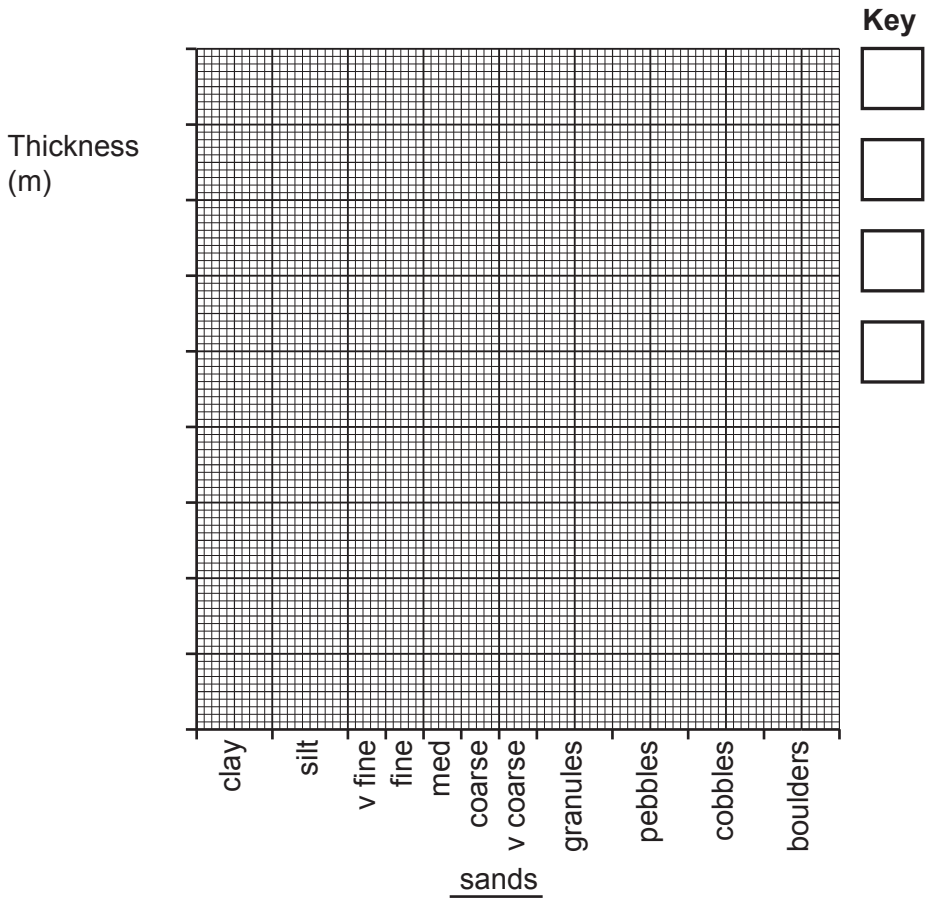
(b) Draw a graphic log of a transgressive coastal succession on the axes provided.



[3]

(c) Suggest how lateral variation and diachronous beds affect the correlation used in relative dating.

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END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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